Annex 46 Second Industry Workshop National and International Energy Policies

ASHRAE Standard 90.1

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GARD Analytics

Chair of 90.1 Energy Cost Budget Subcommittee

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Energy Policy Acts

- 1992 Act
  - Establishes ASHRAE Standard 90.1 as minimum for U.S. building codes
- 2005 Act
  - Provides $1.80/sqft tax deduction for 50% greater efficiency than ASHRAE Standard 90.1
  - Or $0.60/sqft tax deduction for envelope, lighting or HVAC that similarly exceeds efficiency of 90.1

Deduction Details

- Property placed in service
  - December 31, 2005 to December 31, 2007
- Includes
  - interior lighting systems,
  - heating, cooling, ventilation, and hot water systems, or
  - building envelope
- Uses Standard 90.1–2001 as in effect on April 2, 2003 (includes addenda adopted through that date)

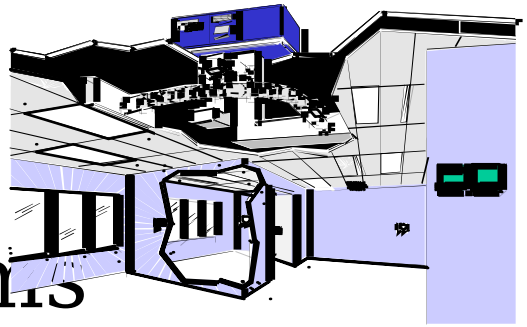
More Deduction Details

- DOE recommend methods for qualifying computer software
- California Title 24 ACM referenced
- Appendix G not referenced
- Inspection and testing by qualified individuals shall be performed.
- Qualified individuals shall be recognized by an organizations certified by IRS
- Waiting on details …

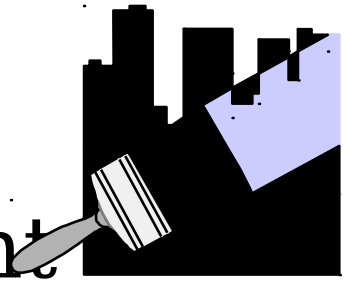
90.1 Purpose

…provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings

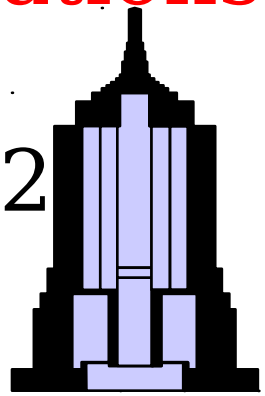
90.1 Scope



- New buildings and systems
- New *portions* of buildings and systems (additions)



- New systems and equipment in *existing* buildings (alterations)
- *Excludes* low-rise residential - (Standard 90.2



Major Sections

- Envelope
  - Insulation and fenestration requirements
- Lighting
  - Lighting power densities and controls
- Mechanical
  - Equipment efficiency and system design

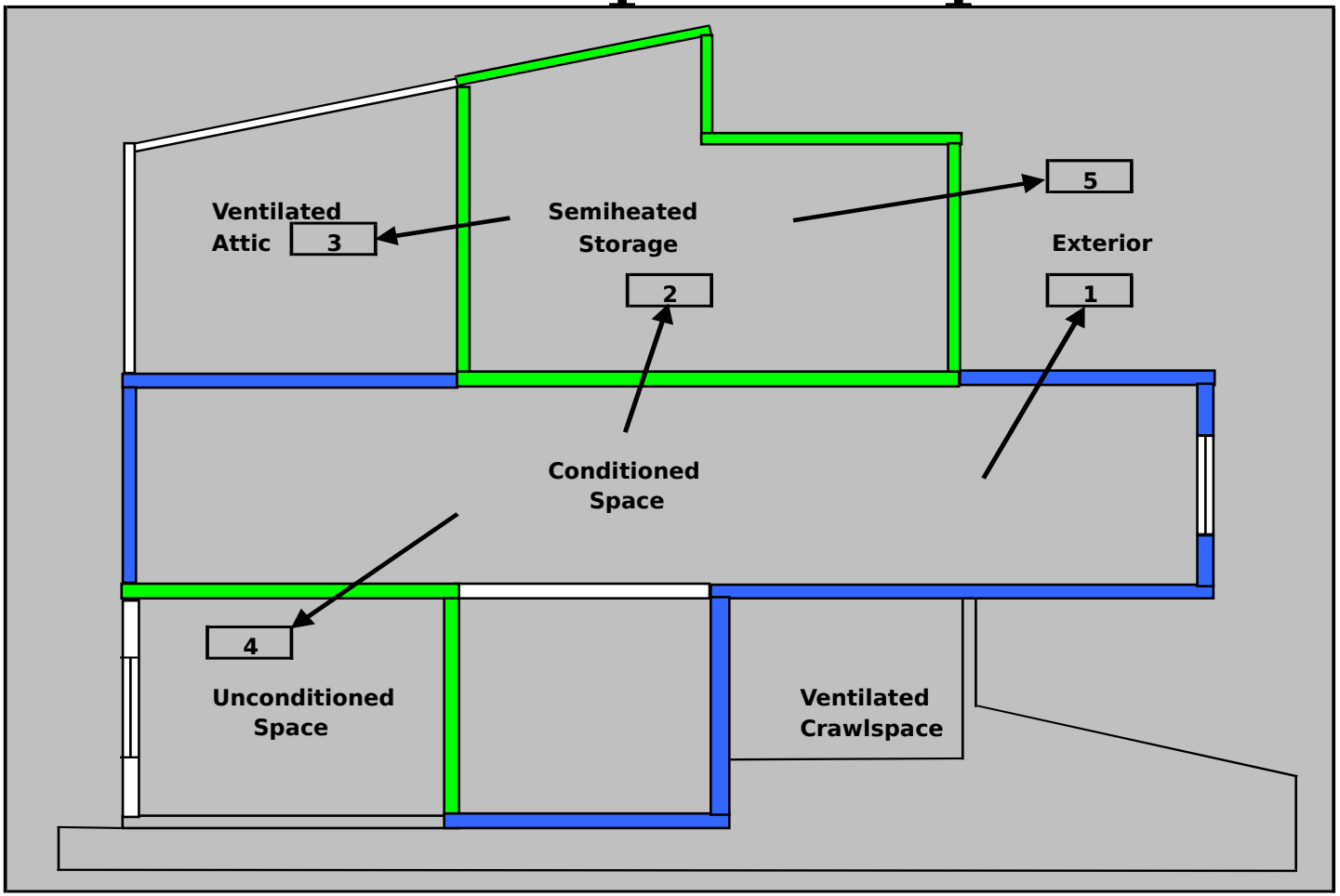
General Layout

- Mandatory requirements
- Prescriptive requirements
- Performance methodology

Envelope

- Requirements
- Insulation Installation
- Fenestration
- Air Leakage/Sealing
- Multiple Compliance Paths

General - Building Envelope Scope



For Envelope – Three Compliance Paths

- Prescriptive requirements by component:
  - U-factor/R-Value, C-factor, F-factor, SHGC
- Envelope Component Tradeoffs
  - Use ENVSTD 4.0
- Whole Building Tradeoffs - Use ECB

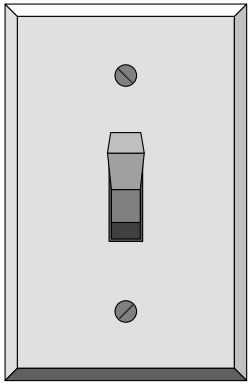
Regardless of compliance path – MUST meet Mandatory Requirements

Opaque Elements	Assembly Maximum	Insulation Min. R-Value
Roofs		
Insulation Entirely above Deck	U-0.063	R-15.0 ci
Metal Building	U-0.065	R-19.0
Attic and Other	U-0.034	R-30.0
Walls, Above Grade		
Mass	U-0.580	NR
Metal Building	U-0.113	R-13.0
Steel Framed	U-0.124	R-13.0
Wood Framed and Other	U-0.089	R-13.0
Wall, Below Grade		
Below Grade Wall	C-1.140	NR
Floors		
Mass	U-0.322	NR
Steel Joist	U-0.350	NR
Wood Framed and Other	U-0.282	NR
Slab-On-Grade Floors		
Unheated	F-0.730	NR
Heated	F-1.020	R-7.5 for 12 in.
Opaque Doors		
Swinging	U-0.700	
Non-Swinging	U-1.450	

Lighting

- Interior spaces of buildings
- Exterior building lighting
- Exterior grounds lighting powered through building
- Exceptions
  - Emergency lighting
  - Lighting required by life safety statute
  - Lighting within living units of buildings
  - Decorative gas lighting

Mandatory Requirements



- Lighting control:
  - Automatic shut-off
  - Control in every space
  - Exterior – time-clock or photosensor
  - Special lighting applications – must be controlled separately
- Tandem wired ballasts; not single-lamp
- Exit signs – 5 watts/face

Prescriptive Requirements

- Interior lighting power allowance – two compliance options:
  - Building area method
  - Space-by-space method
- Exterior lighting power allowance
  - Lighting power densities
  - Tradable – grounds, exits, entrances, canopies,..
  - Non-tradable – facades, drive-up windows,..

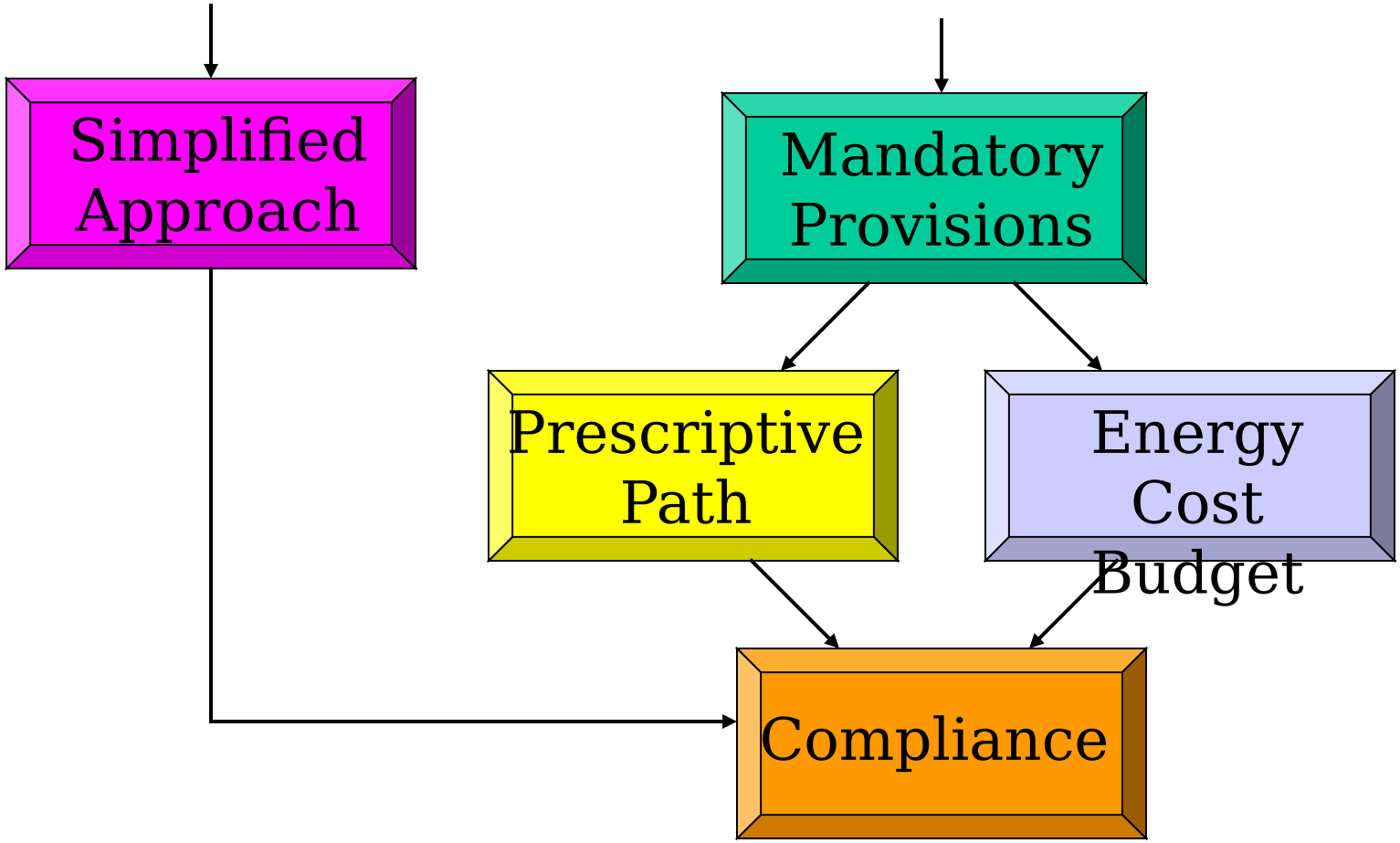
Building Area Method Lighting Power Densities

Hospital	- 1.2 W/ft^2
Library	- 1.3 W/ft^2
Manufacturing	- 1.3 W/ft^2
Museum	- 1.1 W/ft^2
Office	- 1.0 W/ft^2
Parking Garage	- 0.3 W/ft^2
Retail	- 1.5 W/ft^2
School	- 1.2 W/ft^2

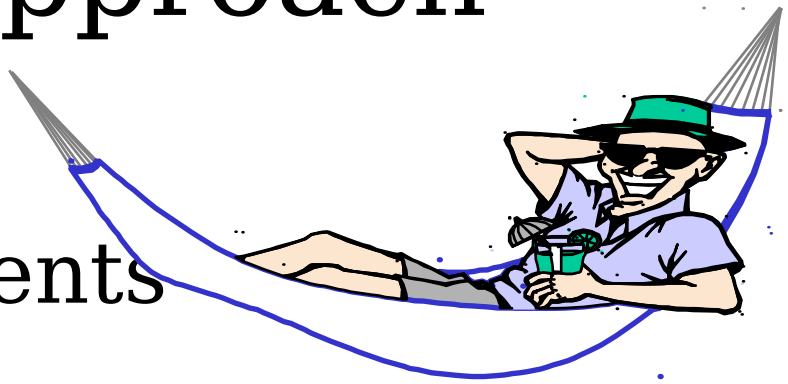
TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method

Common Space Types[a]	LPD (W/ft^2)	Building Specific Space Types	LPD (W/ft^2)
Office-Enclosed	1.1	Gymnasium/Exercise Center	
Office-Open Plan	1.1	Playing Area	1.4
Conference/Meeting/Multipurpose	1.3	Exercise Area	0.9
Classroom/Lecture/Training	1.4	Courthouse/Police Station/Penitentiary	
For Penitentiary	1.3	Courtroom	1.9
Lobby	1.3	Confinement Cells	0.9
For Hotel	1.1	Judges Chambers	1.3
For Performing Arts Theater	3.3	Fire Stations	
For Motion Picture Theater	1.1	Fire Station Engine Room	0.8
Audience/Seating Area	0.9	Sleeping Quarters	0.3
For Gymnasium	0.4	Post Office—Sorting Area	1.2
For Exercise Center	0.3	Convention Center—Exhibit Space	1.3
For Convention Center	0.7	Library	
For Penitentiary	0.7	Card File and Cataloging	1.1
For Religious Buildings	1.7	Stacks	1.7
For Sports Arena	0.4	Reading Area	1.2
For Performing Arts Theater	2.6	Hospital	
For Motion Picture Theater	1.2	Emergency	2.7
For Transportation	0.5	Recovery	0.8
Atrium—First Three Floors	0.6	Nurse Station	1.0
Atrium—Each Additional Floor	0.2	Exam/Treatment	1.5

HVAC Compliance Paths



Simplified Approach



Provides a set of simplified requirements that are limited to…

- Buildings with 1 or 2 stories
- Buildings < 25,000 ft^2 gross floor area
- Single-zone systems
- Air cooled or evaporatively cooled

Equipment

- Packaged air conditioners
- Heat pumps
- Chillers (std. and variable rating points)
- Packaged terminal/ room air conditioners/ heat pumps
- Furnaces
- Boilers
- Heat rejection equipment

TABLE 6.8.1A Air Conditioners and Condensing Units

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Air Conditioners, Air Cooled	<65,000 Btu/h[c]	All	Split System	10.0 SEER (before 1/23/2006) 12.0 SEER (as of 1/23/2006)	ARI 210/240
			Single Package	9.7 SEER (before 1/23/2006) 12.0 SEER (as of 1/23/2006)	
Through-the-Wall, Air Cooled	≤ 30,000 Btu/h[c]	All	Split System	10.0 SEER (before 1/23/2006) 10.9 SEER (as of 1/23/2006) 12 SEER (as of 1/23/2010)	
			Single Package	9.7 SEER (before 1/23/2006) 10.6 SEER (as of 1/23/2006) 12.0 SEER (as of 1/23/2010)	
Small-Duct High-Velocity, Air Cooled	< 65,000 Btu/h[c]	All	Split System	10 SEER	
Air Conditioners, Air Cooled	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.3 EER	ARI

Other Mandatory Requirements

- Load calculations
- HVAC controls
- Pipe and duct insulation
- Operation and maintenance manuals

Prescriptive Requirements

- Economizers – air-side or water-side
- Simultaneous heating and cooling
- Air system design and control
- Fan power limitations
- Hydronic system design and control
- Heat rejection equipment control & limitations
- Heat recovery
- Exhaust hoods

TABLE 7.8 Performance Requirements for Water Heating Equipment

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Performance Required [a]	Test Procedure[b]
Electric Water Heaters	≤12 kW	Resistance ≥20 gal	0.93-0.00132V EF	DOE 10 CFR Part 430
	>12 kW	Resistance≥20 gal	20 + 35 V SL, Btu/h	ANSI Z21.10.3
	≤24 Amps and ≤250 Volts	Heat Pump	0.93-0.00132V EF	DOE 10 CFR Part 430
Gas Storage Water Heaters	≤75,000 Btu/h	≥20 gal	0.62-0.0019V EF	DOE 10 CFR Part 430
	>75,000 Btu/h	<4000 (Btu/h)/gal	80% E_t (Q/800 + 110 V) SL, Btu/h	ANSI Z21.10.3
Gas Instantaneous Water Heaters	>50,000 Btu/h and <200,000 Btu/h	≥4000 (Btu/h)/gal and <2 gal	0.62-0.0019V EF	DOE 10 CFR Part 430
	≥200,000 Btu/h[c]	≥4000 (Btu/h)/gal and <10 gal	80% E_t	ANSI Z21.10.3
	≥200,000 Btu/h	≥4000 (Btu/h)/gal and ≥10 gal	80% E_t (Q/800 + 110 V) SL, Btu/h	
Oil Storage Water Heaters	≤105,000 Btu/h	≥20 gal	0.59-0.0019V EF	DOE 10 CFR Part 430
	>105,000 Btu/h	<4000 (Btu/h)/gal	78% E_t (Q/800 + 110 V) SL, Btu/h	ANSI Z21.10.3
Oil Instantaneous Water Heaters	≤210,000 Btu/h	≥4000 (Btu/h)/gal and <2 gal	0.59-0.0019V EF	DOE 10 CFR Part 430

ECB

- Section 11 - Energy Cost Budget Method
  - Trade off method for code compliance
  - Only used when prescriptive criteria are not flexible enough
- Appendix G – Performance Rating Method
  - Determine how much better than 90.1
  - Used in beyond code rating programs
  - Informative
- Both use building energy simulation

Sec 11 - Introduction

- Based on overall building performance expressed as “energy cost budget”
- Budget based on prescriptive measures
- Trade-offs between measures
- Optimize the design

Sec 11 - General Information

- Computer simulation of whole building
- ALL mandatory provisions must be met
- Does not predict actual energy costs
- Limitations - can’t use ECB if
  - No mechanical system
  - No envelope design
- Trade-off only measures in the permit

Sec 11 - How ECB Method Works

Proposed Design

Meets mandatory requirements

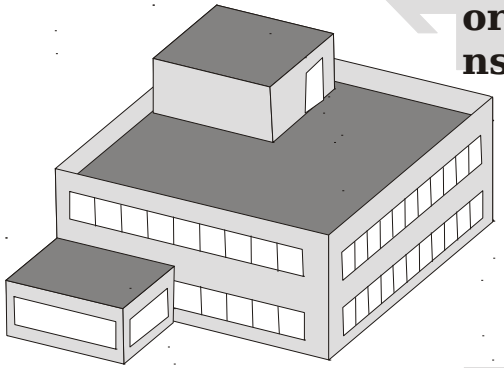
As designed: envelope, lighting, HVAC & SWH

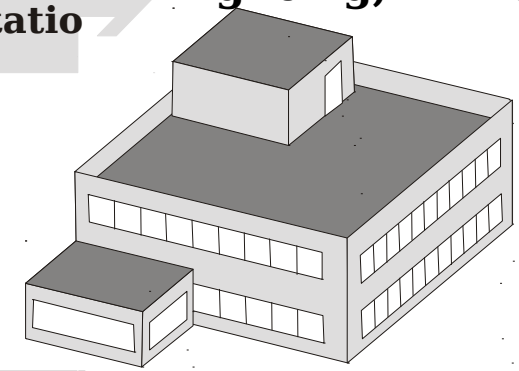
Budget Building Design

Meets mandatory requirements.

Meets prescriptive requirements for envelope, lighting, HVAC & SWH

Identical surfaces & orientations*





Simulation Model

Simulation Model

Identical weather, schedules & energy rates

Design Energy Cost ≤ **Energy Cost Budget**

***Unless glazing area in budget design required adjustment**

Sec 11 - Design Energy Cost

- Results from simulation of “proposed design”
- Lighting - classify areas as per ltg. tables
- Envelope
- HVAC & SHW- model specified features
- Exempt features are “energy neutral”
- Special cases for partial buildings, heated-only, simplifications, etc.

Sec 11 - Energy Cost Budget

- Results from simulation of “budget building design”
- Same size, shape, orientation as the “proposed design”, but:
  - Just meets all prescriptive requirements for envelope, lighting, HVAC and service water heating
  - No overhangs or shading for fenestration
  - HVAC system type determined by proposed design
  - All others identical to design energy cost run
- Design Energy Cost may not exceed Energy Cost Budget

Compliance Calculations

Budget building and proposed design simulations must both use:

- Same simulation program
- Same climate data (approved by AHJ)
- Same “purchased energy rates” (approved by AHJ)
- Same schedules of operation, temp. setpoints, etc.
- Same thermal blocks (i.e. zoning)

It’s an apples-to-apples, hourly, whole building simulation, comparison

ECB Method Conclusion

- ECB Method not needed if design meets prescriptive standards
- Detailed ECB requirements provide clear guidance on doing a fair analysis
- Useful for optimizing design or dealing with unusual building requirements
- Requires engineering skill & judgment

App G – The Basics

- Performance Rating Method
  - Beyond Code
  - Use in Energy Policy Act 2005 tax deduction?
- Many parallels to Section 11
  - Mandatory requirements of rest of standard
  - Building energy simulation program
  - Big side-by-side table of requirements
- Baseline building performance vs. proposed building performance

  %improve = 100 x (baseline – proposed) / baseline
- Actual rates or state average
- Baseline HVAC based on building size

TABLE G3.1 *(Continued)* Modeling Requirements for Calculating Proposed and Baseline Building Performance

No.	Proposed Building Performance	Baseline Building Performance
4.	**Schedules**	
	Schedules capable of modeling hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat setpoints, and HVAC system operation shall be used. The schedules shall be typical of the proposed building type as determined by the designer and approved by the *rating authority*. **HVAC Fan Schedules**. Schedules for HVAC fans shall run continuously whenever spaces are occupied and shall be cycled on and off to meet heating and cooling loads during unoccupied hours. **Exception:** Where no heating and/or cooling system is to be installed and a heating or cooling system is being simulated only to meet the requirements described in this table, heating and/or cooling system fans shall not be simulated as running continuously during occupied hours but shall be cycled on and off to meet heating and cooling loads during all hours.	Same as Proposed Design. **Exception:** Schedules may be allowed to differ between *proposed design* and *baseline building design* when necessary to model nonstandard *efficiency* measures, provided that the revised schedules have the approval of the rating authority. Measures that may warrant use of different schedules include, but are not limited to, lighting controls, natural ventilation, demand control ventilation, and measures that reduce service water heating loads.
5.	**Building Envelope**	
	All components of the *building envelope* in the *proposed design* shall be modeled as shown on architectural drawings or as built for existing building envelopes. **Exceptions:** The following building elements are permitted to differ from architectural drawings. (a) All uninsulated assemblies (e.g., projecting balconies, perimeter edges of intermediate floor stabs, concrete floor beams over parking garages) shall be separately modeled. Any other envelope assembly that covers less than 5% of the total area of that assembly type (e.g., exterior walls) need not be separately described provided that it is similar to an assembly being modeled. If not separately described, the area of an envelope assembly shall be added to the area of an assembly of that same type with the same orientation and thermal	Equivalent dimensions shall be assumed for each exterior envelope component type as in the *proposed design*; i.e., the total gross area of exterior walls shall be the same in the *proposed* and *baseline building designs*. The same shall be true for the areas of roofs, floors, and doors, and the exposed perimeters of concrete slabs on grade shall also be the same in the *proposed* and *baseline building designs*. The following additional requirements shall apply to the modeling of the *baseline building design*: **(a) Orientation.** The *baseline building performance* shall be generated by simulating the building with its actual orientation and again after rotating the entire building 90, 180, 270 degrees, then averaging the results. The building shall be modeled so that it does not shade itself. **(b) Opaque assemblies.** Opaque assemblies used for new buildings or *additions* shall conform with the following common, lightweight assembly types and shall match the appropriate assembly maximum U-factors in

App G - Schedules

- Exception for efficiency measures that are modeled with schedule changes
  - Lighting control
  - Natural ventilation
  - Demand controlled ventilation
  - Service water heating load reductions

App G - Envelope

- May be greater than 40% glazing
- Baseline
  - Minimum requirements for insulation and windows
  - Compared to lower of actual or 40% glazing
  - No external shading
  - Building simulated in four cardinal directions and averaged
- Provides credit for shading and window location

App G - Lighting

- Daylighting credit
- Power adjustments for controls
  - Programmable timing control
  - Occupancy sensors
  - Both

App G – HVAC

- Rewards system selection
- Rewards fan power
  - Specific formula for baseline
- Rewards economizer use if not usually required
- More direct requirements instead of many references to other sections
- Rewards exemplary chilled water plants

App G – Baseline System

TABLE G3.1.1A ***Baseline*** **HVAC System Types**

Building Type	Fossil Fuel, Fossil/Electric Hybrid, & Purchased Heat	Electric and Other
Residential	System 1 – PTAC	System 2 - PTHP
Nonresidential & 3 Floors or Less & <75,000 ft^2	System 3 – PSZ-AC	System 4 – PSZ-HP
Nonresidential & 4 or 5 Floors & <75,000 ft^2 or 5 Floors or Less & 75,000 ft^2 to 150,000 ft^2	System 5 - Packaged VAV w/ Reheat	System 6 - Packaged VAV w/PFP Boxes
Nonresidential & More than 5 Floors or >150,000 ft^2	System 7 - VAV w/Reheat	System 8 - VAV w/PFP Boxes

Notes:
Residential building types include dormitory, hotel, motel, and multifamily. Residential space types include guest rooms, living quarters, private living space, and sleeping quarters. Other building and space types are considered nonresidential.
Where no heating system is to be provided or no heating energy source is specified, use the "Electric and Other" heating source classification.
Where attributes make a building eligible for more than one *baseline* system type, use the predominant condition to determine the system type for the entire building.

Questions